# Prototyping the Emergency Smoke Response System (ESRS)

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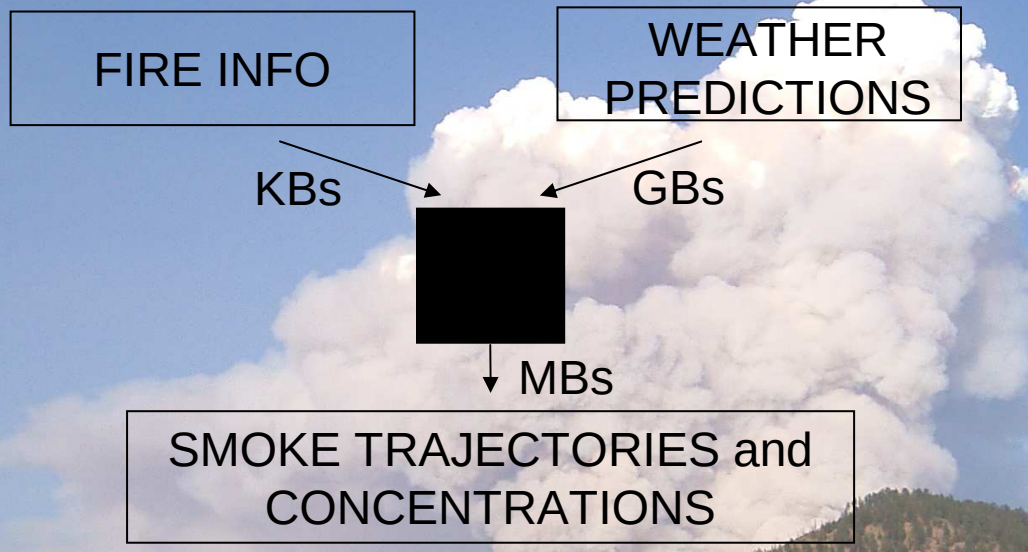
CARPA
October 16, 2008

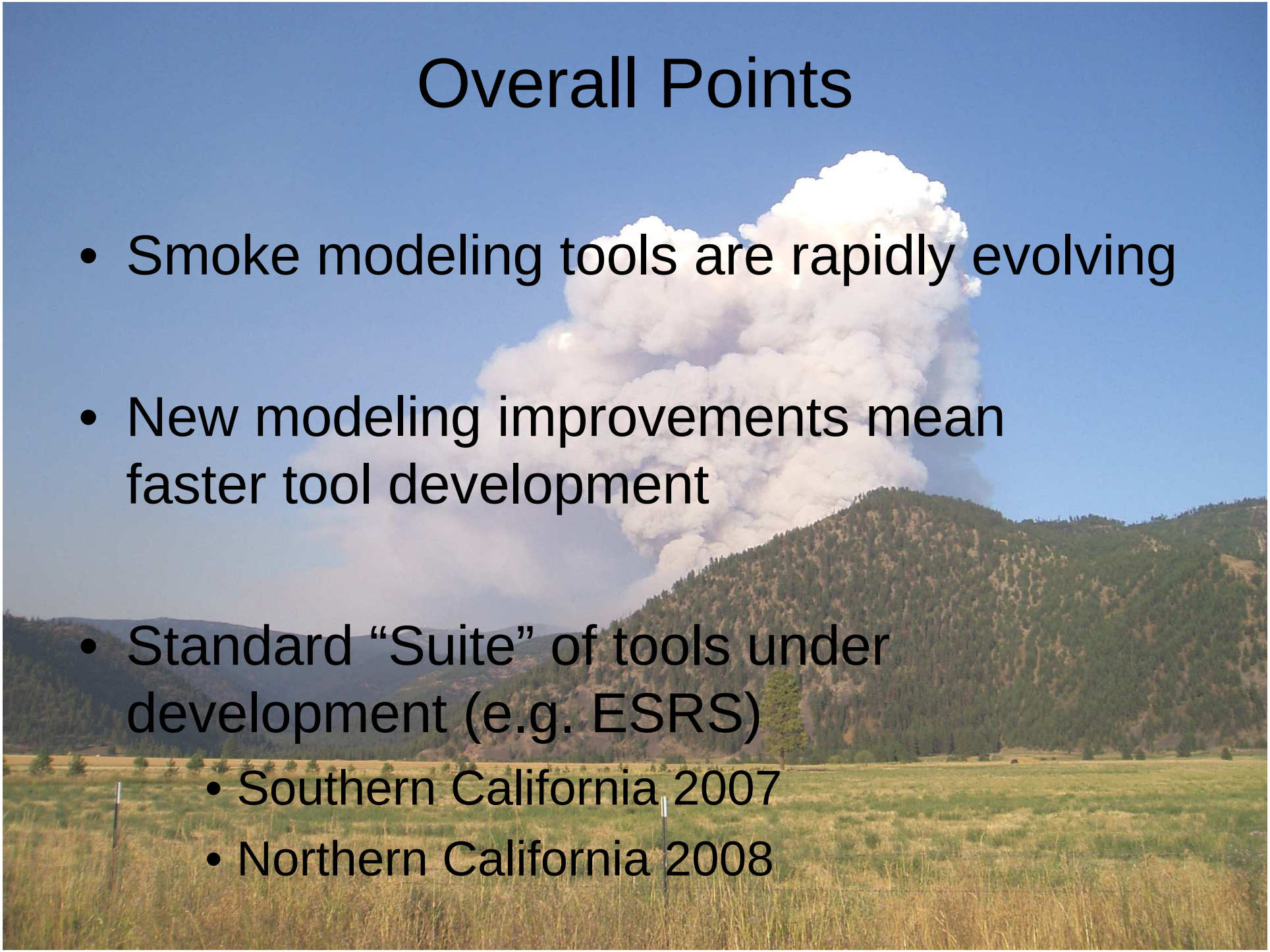
# Smoke Modeling




- Scale: kilometers to 100's of km; days
- Multiple, ill-defined sources across a wide region
- Real-time forecasts as well as after-action

Generally: 3-D Met models; PM (+chemistry); server-run; web-delivered

# Overall Points



- Smoke modeling tools are rapidly evolving
- New modeling improvements mean faster tool development
- Standard “Suite” of tools under development (e.g. ESRS)
  - Southern California 2007
  - Northern California 2008

# Smoke is a growing issue

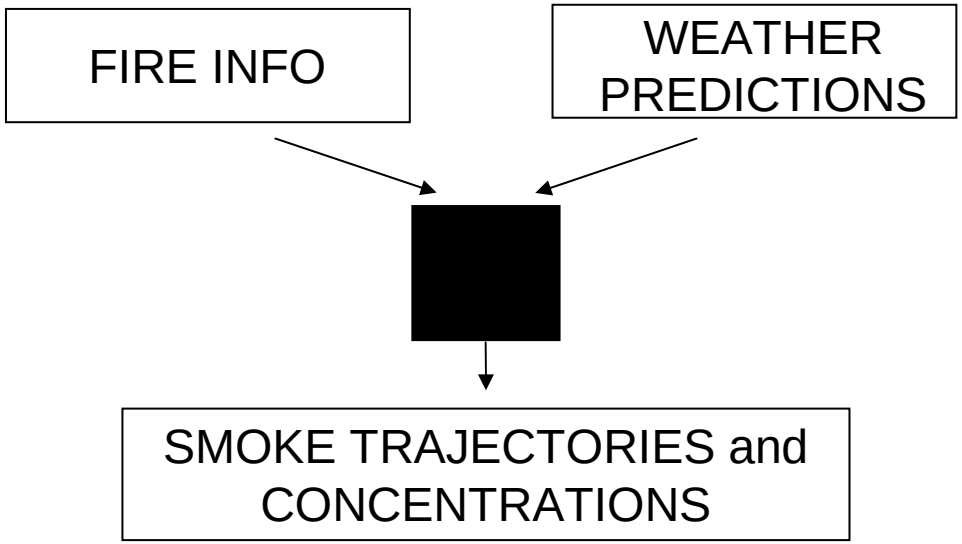
More fire
*Increasing wildfires, WFU and Rx fires*

Decreased public acceptance of smoke
*More health awareness, encroachment (WUI)*

Tightening regulations
*NAAQS standards ($PM_{2.5}$ & $O_3$), regional haze rule, exceptional events standards*

# There is more we can do - now

Smoke Tools are inherently technology dependent
*Even more so than weather forecasts*




Too technological to be done on desktops/laptops

But technology has advanced massively
*Now we have the world-wide web*

# The State of Smoke Tools

MODELS + USER INTERFACE = DECISION SUPPORT APP

## Technology Development Progression

**Emergent** → **Mature**

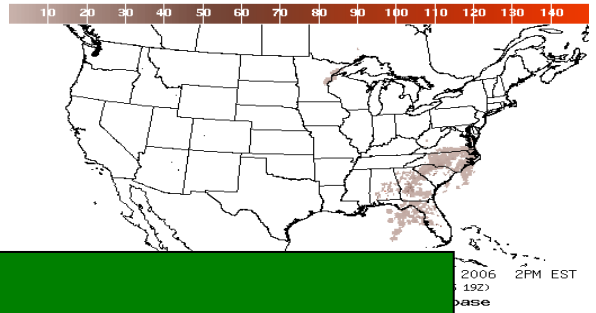
*few,*
*'silos',*
*confusing*

*user choices,*
*inter-operability,*
*ease of use*

# National Smoke Products

National Weather Service

- smoke only (12-km) & aq (36-km)



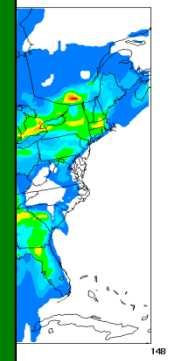

STI C

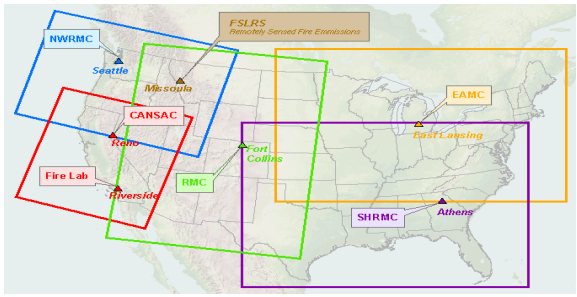
- [illegible]
- [illegible]

FCA

- [illegible]
- regional hi-res (4-km)
- national 12-km 3-day (based on NWS NAM)
- national 36-km 7-day (based on NWS GFS)

All based on the modular BlueSky Smoke Modeling Framework developed by the USFS, STI, & partners





# Lessons Learned

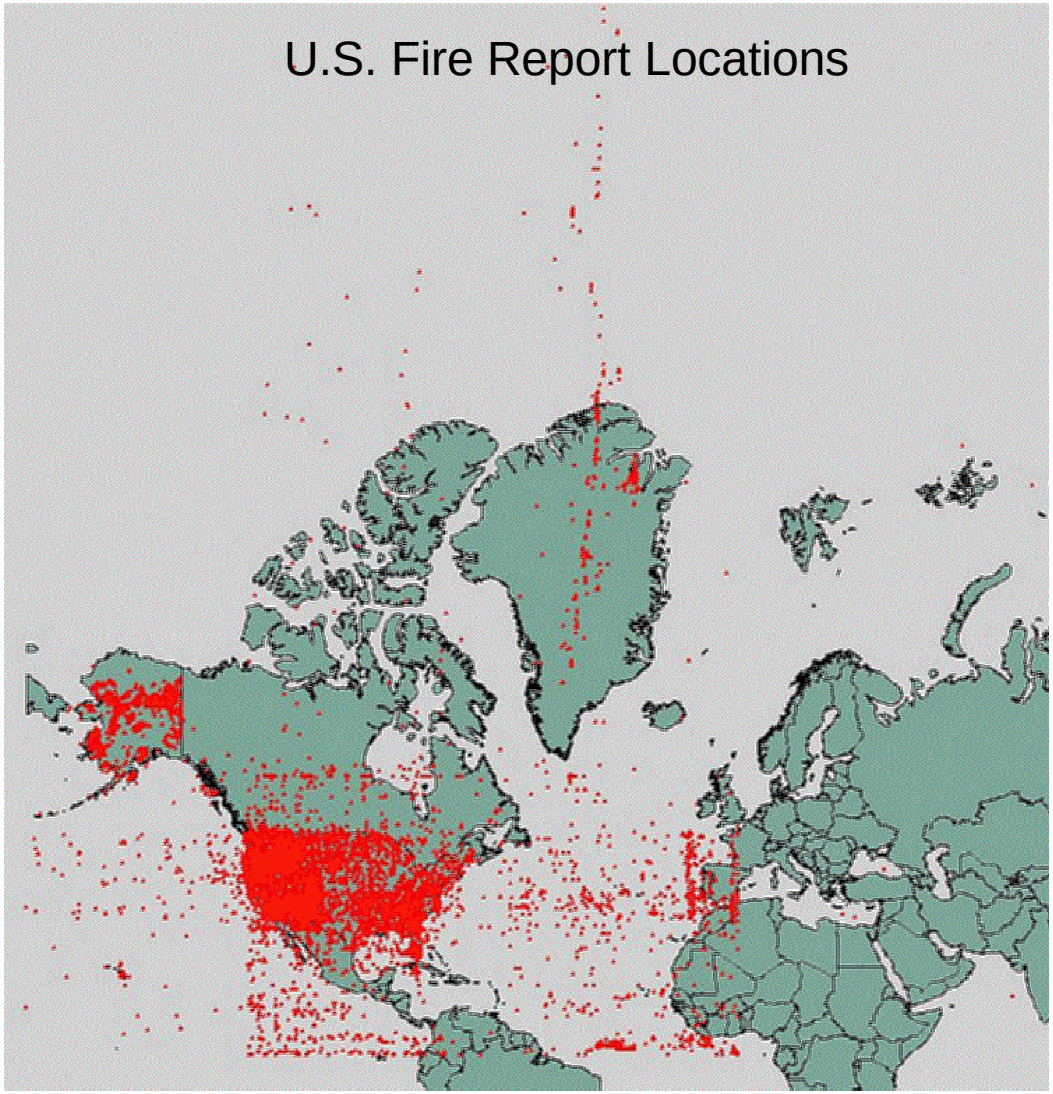
Long-range transport looks good;

Underprediction of ground concentrations

*Fire information is of poor quality*

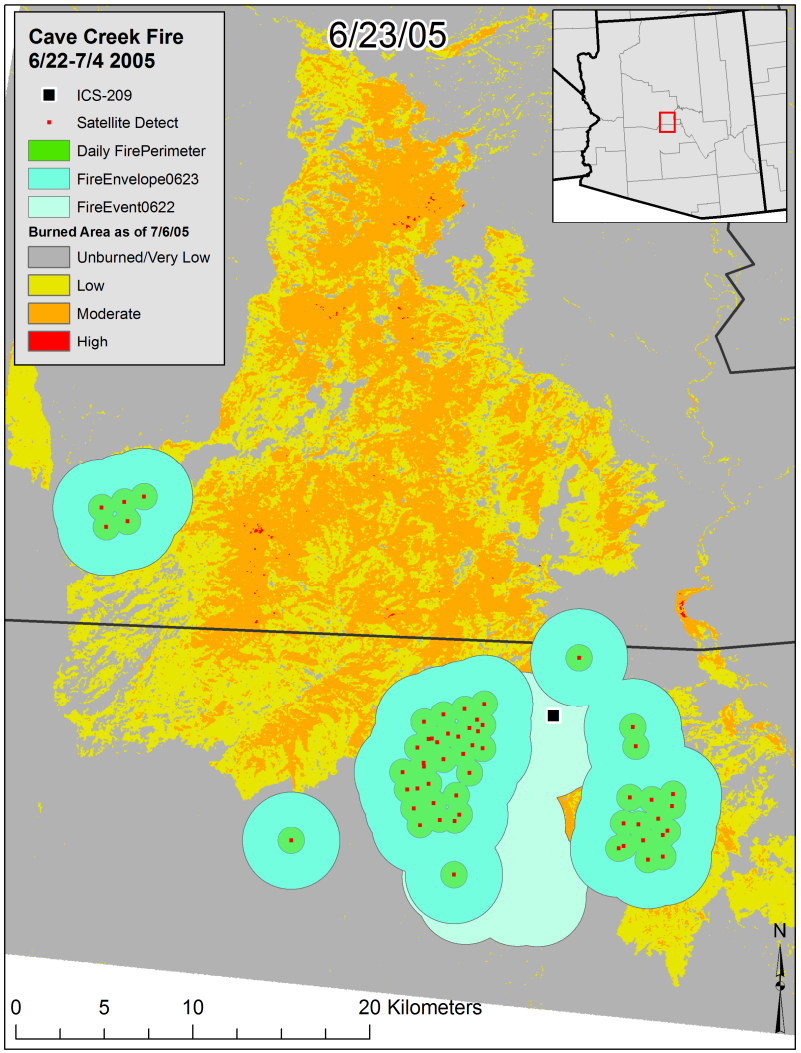
*Models differ substantially*

*Plume rise needs fixing*



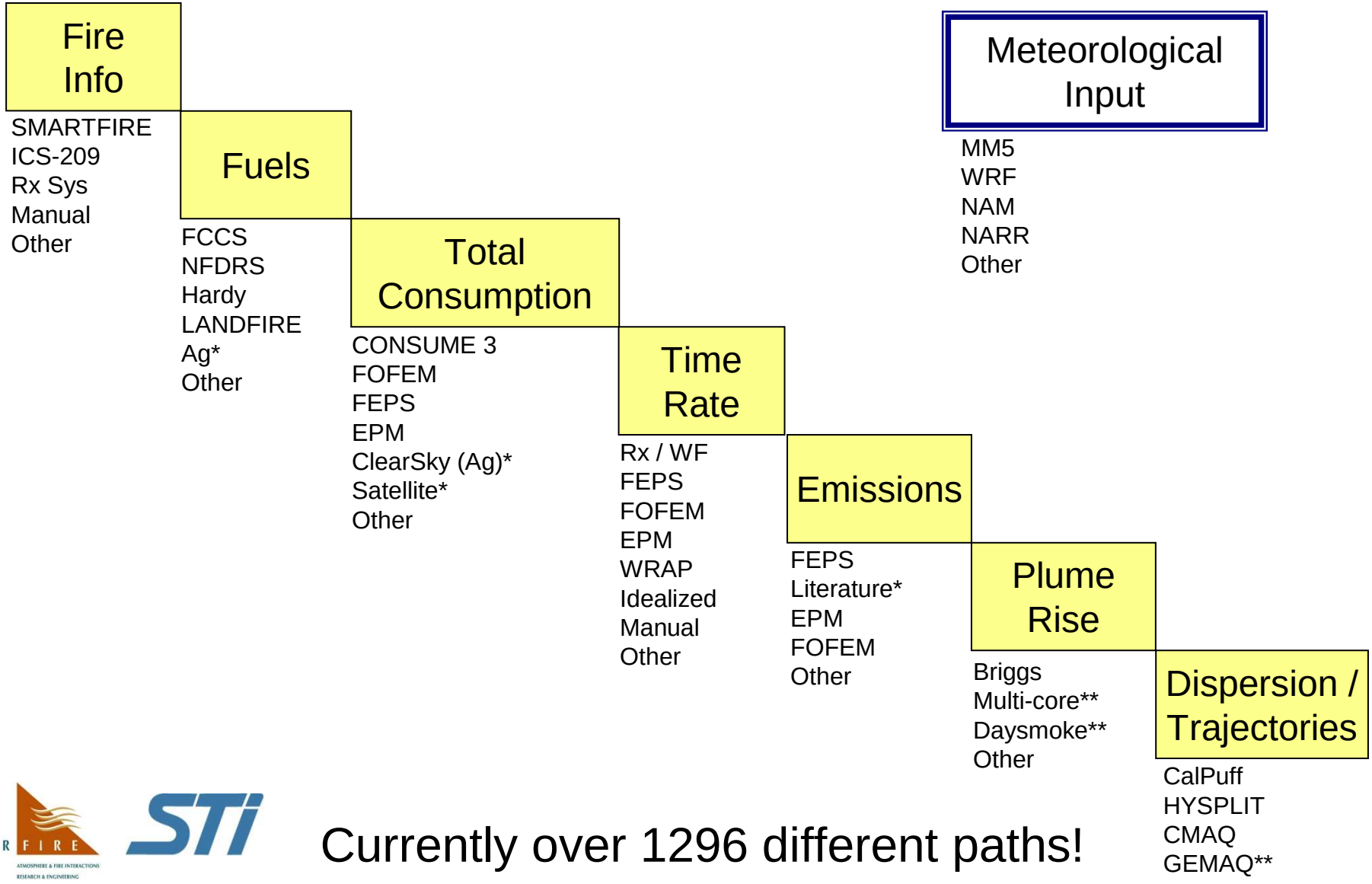
# SMARTFIRE: Reconciled fire data

- Ground reports
- Satellite fire detects (NOAA HMS)
- Expert users (IC Teams)



# The BlueSky Framework:

## Logical, Modular Steps from Fire Info to Smoke Impacts



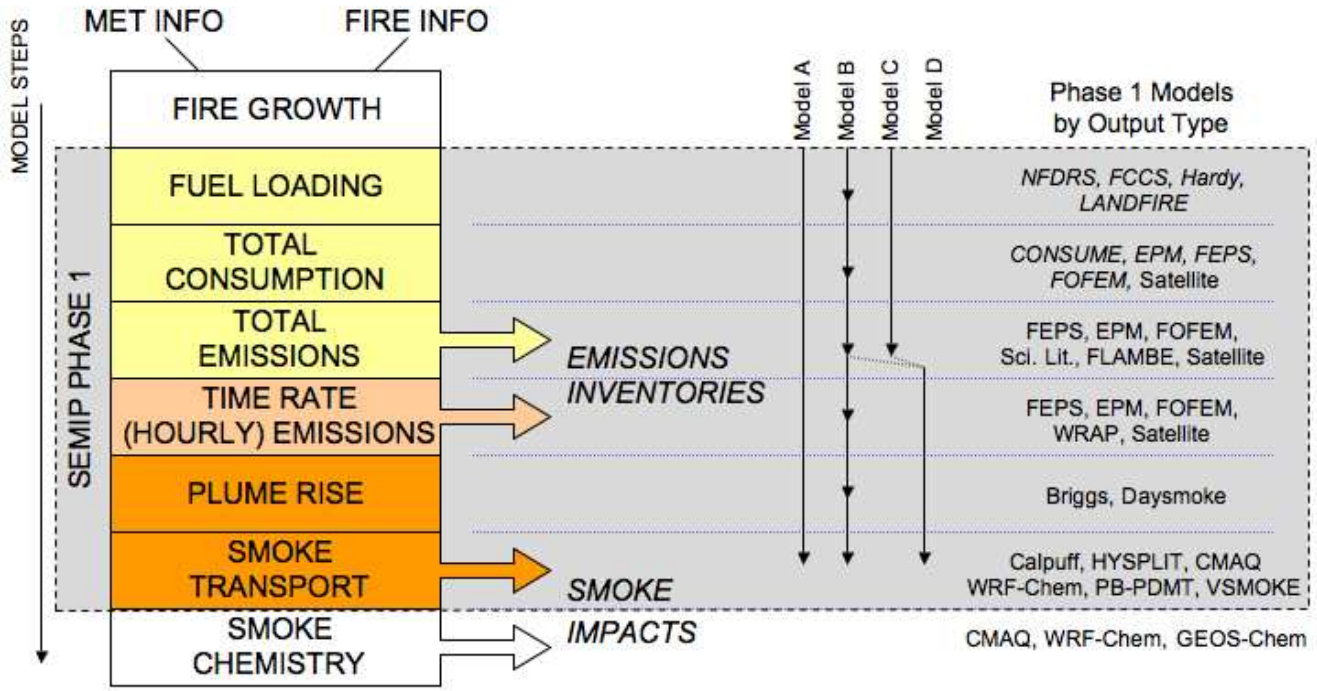

Currently over 1296 different paths!

# Smoke and Emissions Model Inter-comparison Project (SEMIP)

Just funded

Large-scale, Inclusive

Based on other "MIPs"



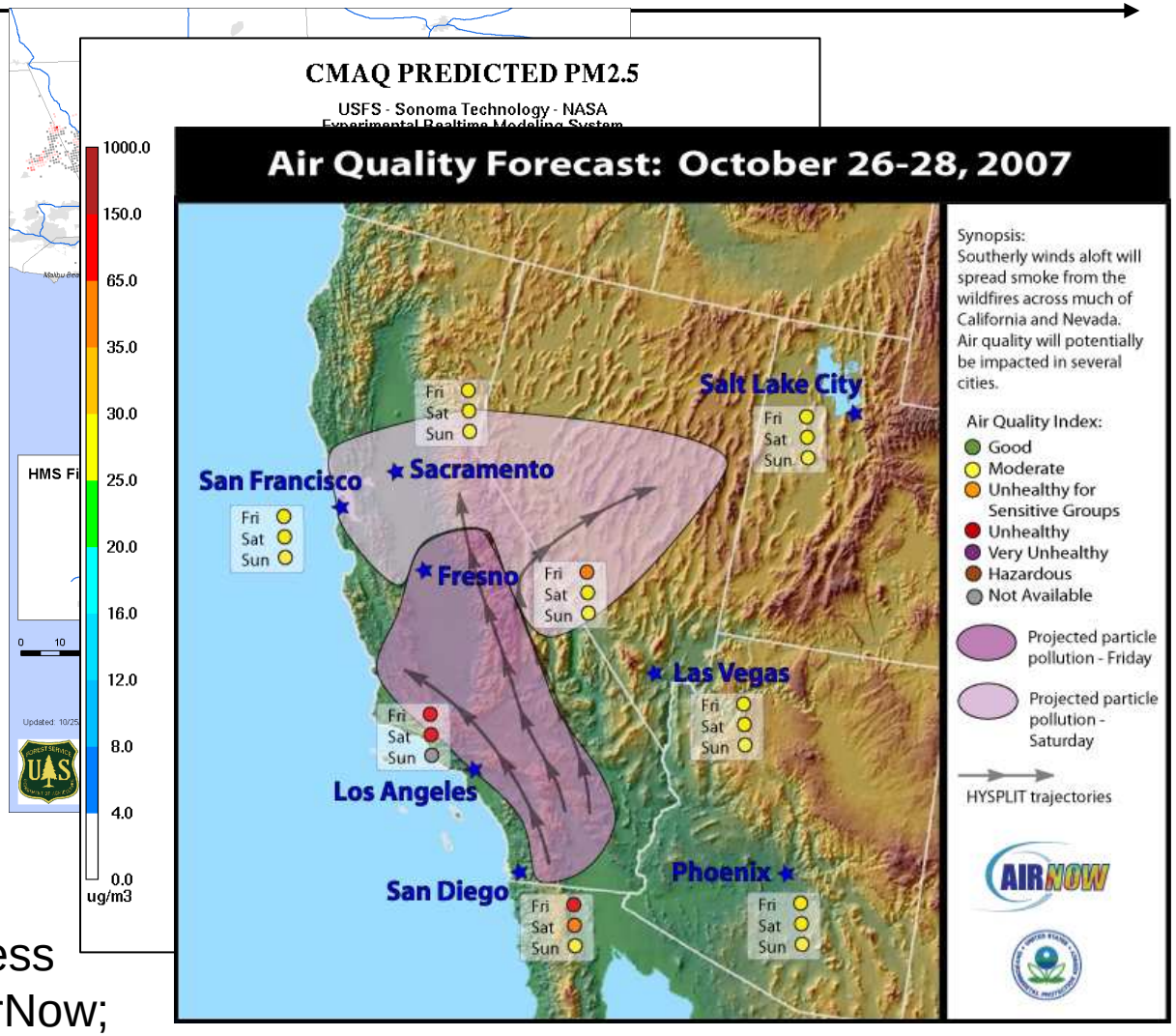
# Plume Rise

- Fires are currently modeled as single plumes, lofting smoke unrealistically high and lowering ground impacts

- In reality, fires are made of many burning areas lofting smoke to various heights

# Southern California Fires 2007

- asked by USDA for data
- supplemented other sources (e.g. NWS)
- SMARTFIRE (HMS&ICS) fire info
- CMAQ and CALPUFF model outputs
- Used:
  - internally by USFS fire resource managers;
  - in Smog Stories and press releases by USDA & AirNow;
  - on White House conf call



# Northern California Fires 2008

State of Emergency / Presidential Declaration

Enormous Smoke Impacts (> 5 million people affected)

USFS AirFire Team & Partners (STI, DRI) asked to develop prototype ESRS by Region 5

Federal / Private / University partnership

Rapid Response basis

Emergency Smoke Response System:
Experimental Predictions

home
contact us

Forecast | Model Output | Monitoring

FOCUS:

1. Additional monitoring

2. Higher resolution
3. On-the-fly trajectories
4. Other species (e.g. Ozone)
5. Smoke apportionment by source fire

6. Provide Forecasts

*expert interpreted forecast text and graphics*

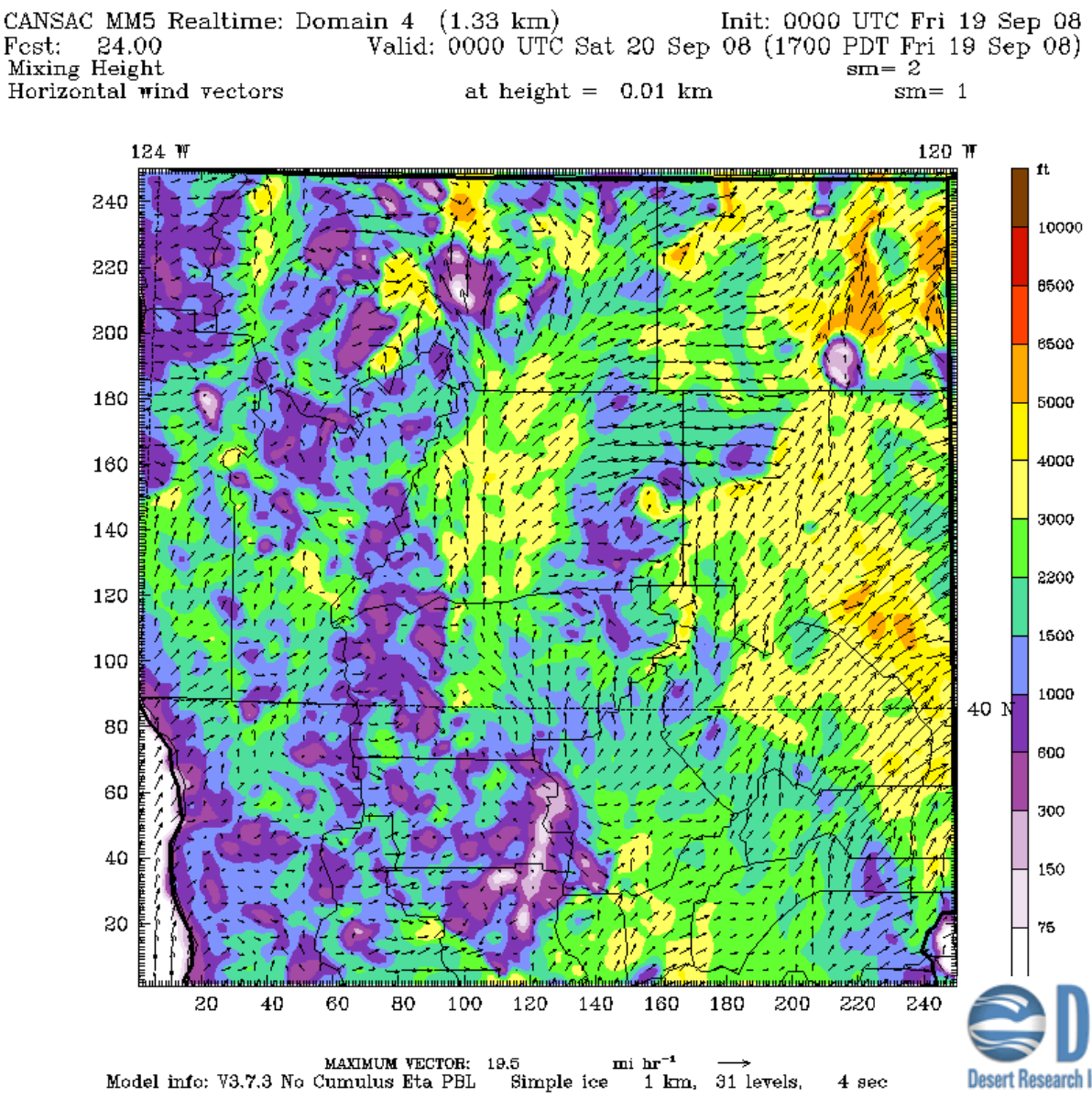
# Very High Resolution

High resolution (1.33 km) meteorology and smoke dispersion

For both fire behavior and air quality

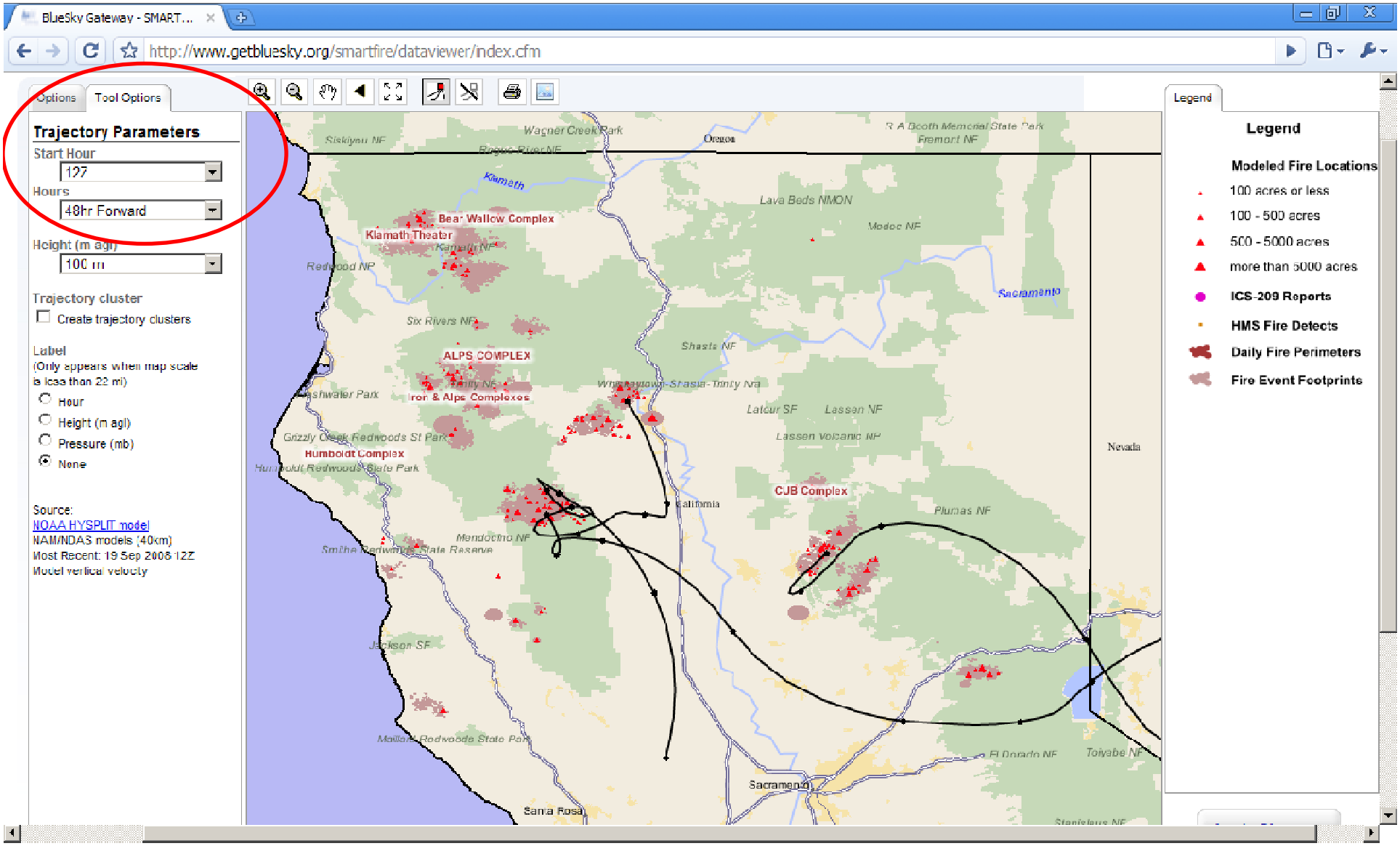
Winds, temperature, RH, mixing height, and smoke $PM_{2.5}$

Java animations available online




Desert Research Institute

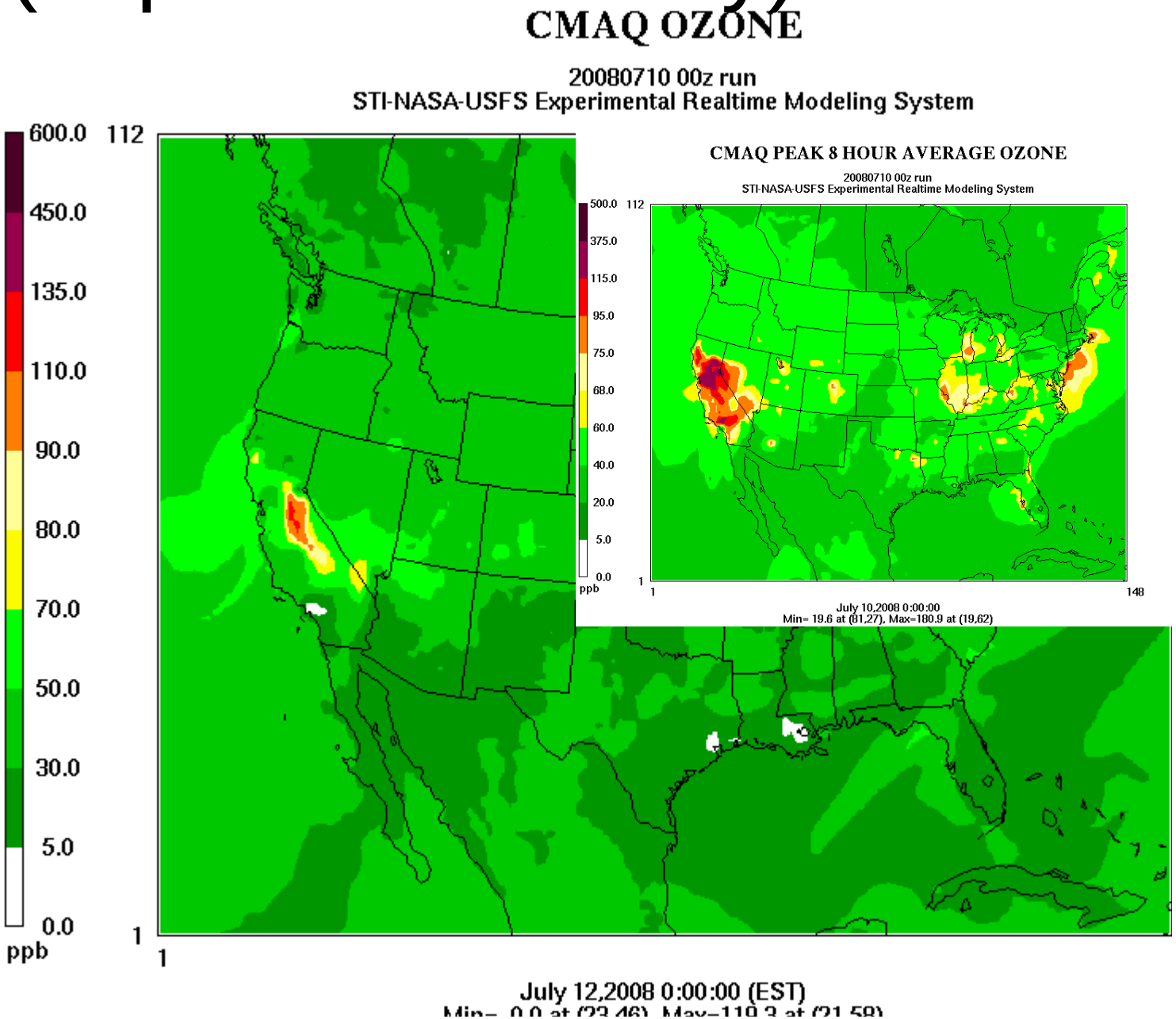
# On Demand Trajectories



# Ozone (experimental only)

Daily 36-km air quality model

Includes fires, other sources, and photochemistry

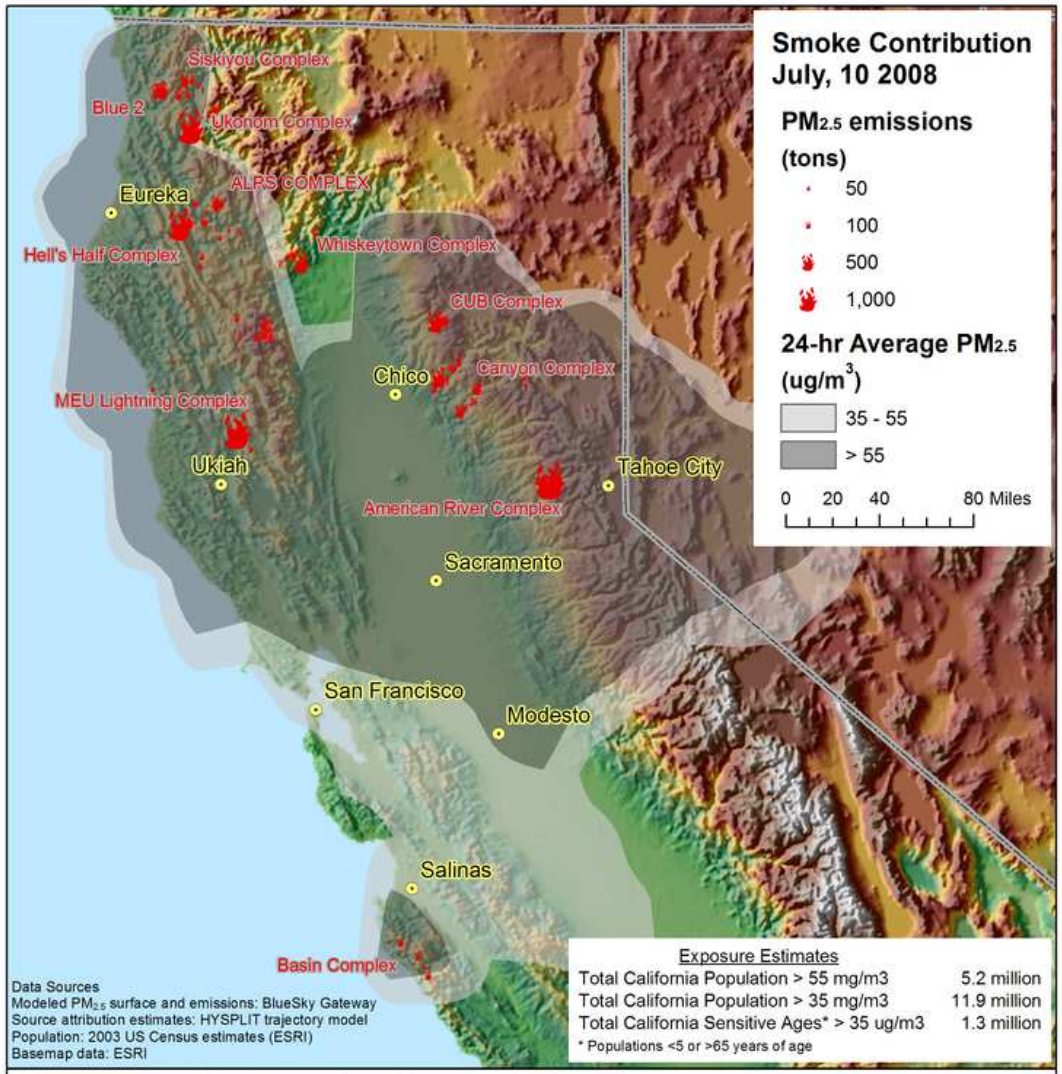


# Smoke Exposure Contribution Map

Combines modeled emissions and transport to determine which fires are likely to contribute to unhealthy air


**Transport Density**

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 1




**Primary sources of smoke at selected locations (estimated percentage)**

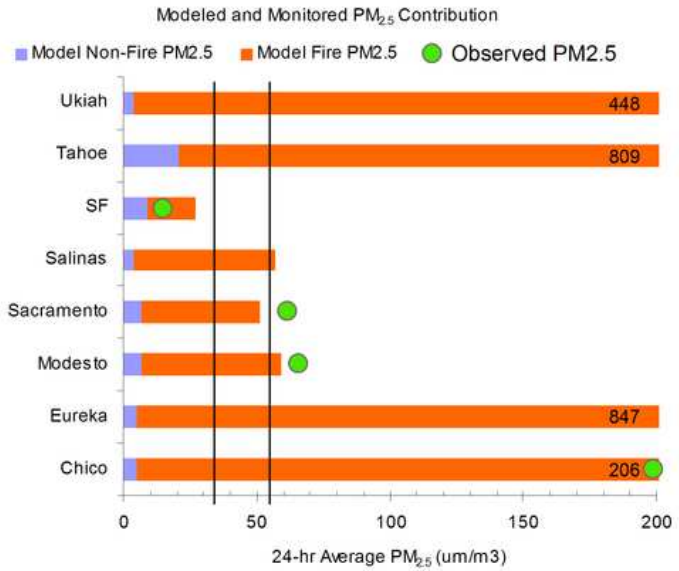
| Fire or Complex | Chico | Eureka | Modesto | Sacramento | Salinas | SF | Tahoe | Ukiah |
|---|---|---|---|---|---|---|---|---|
| Hell's Half Complex | | 2 | 52 | 18 | | 5 | | 26 |
| Basin Complex | | | | | 97 | | | |
| Ukonom Complex | | 18 | | | | 57 | | 17 |
| Canyon Complex | 50 | 1 | | 7 | | | 30 | |
| CUB Complex | 47 | 1 | | 26 | | 6 | 7 | |
| MEU Lightning Complex | | | 15 | 32 | | | | 32 |
| American River Complex | | | | | | | 58 | |
| Blue 2 | | 37 | | | | 9 | | 5 |
| Badger Mountain, WA | | 26 | | | | 10 | | |
| Alps Complex | | 1 | 15 | 5 | | 6 | | 9 |
| Siskiyou Complex | | 12 | | | | 3 | | 1 |
| Whiskeytown Complex | 3 | | 7 | 3 | | | 1 | 2 |

# Exceptional Event Analysis

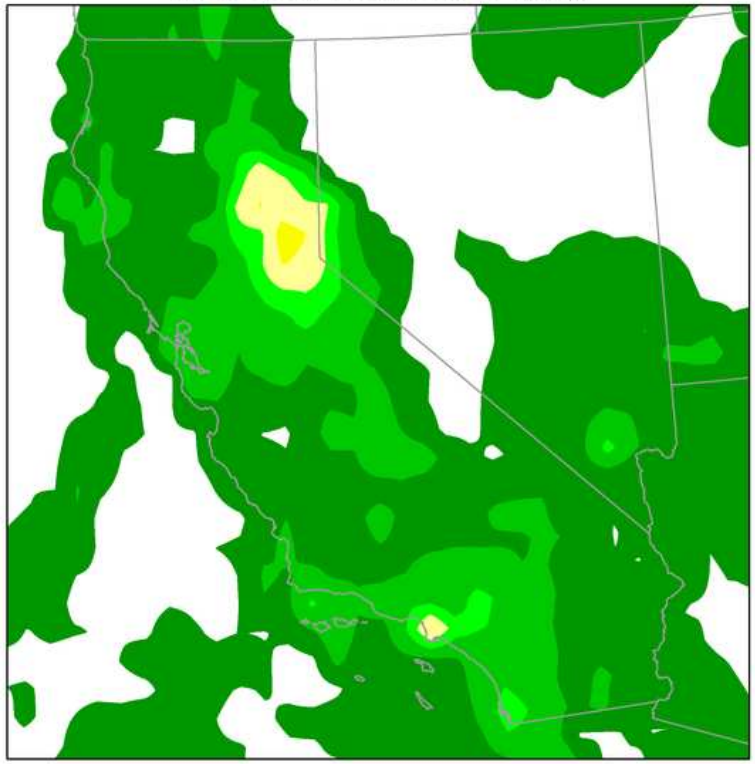
To determine whether National Ambient Air Quality Standard (NAAQS) exceedances are the result of an exceptional event (e.g., one or more large wildfires) it must be shown that the exceedances would not have occured without the event. $PM_{2.5}$ is modeled as two separate layers by the BlueSky Gateway Experimental Modeling System, one layer for smoke and one for all other pollution sources.

The modeled 24-hour $PM_{2.5}$ concentrations from non-fire, fire, and combined sources are shown here. In this case, fire sources dominate. The modeling suggests that none of the analysis cities would have violated the standards if the fires were absent and these exceedances could be argued to be exceptional events.

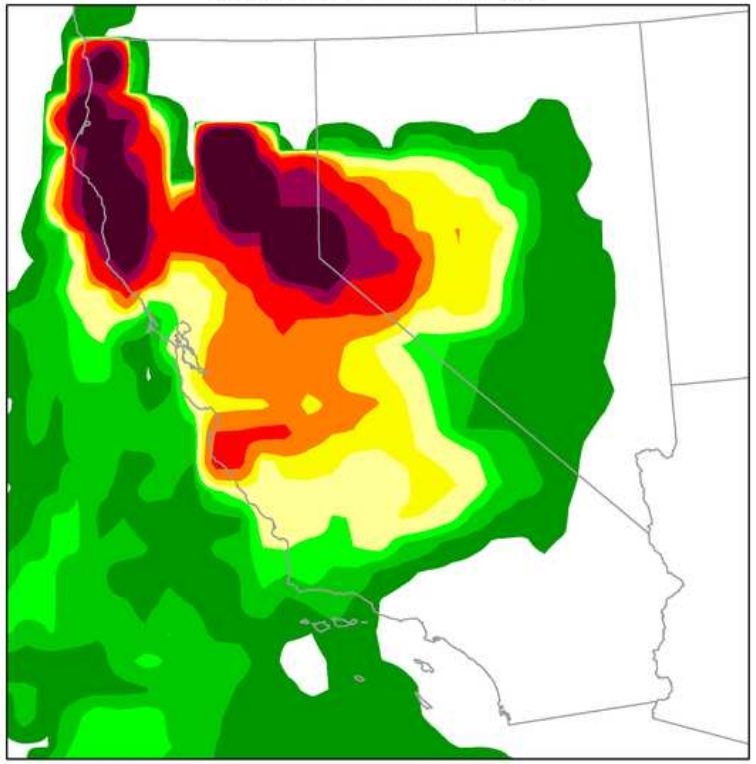
Observed concentrations were also examined to verify the model predictions. Measurments from the AIRNow Program are plotted on the total $PM_{2.5}$ map and on the graph for analysis cities that had reporting monitors for this date. In this case, the model performed very well.




## Modeled Non-Fire $PM_{2.5}$



## Modeled Fire $PM_{2.5}$



# Northern California Fires 2008

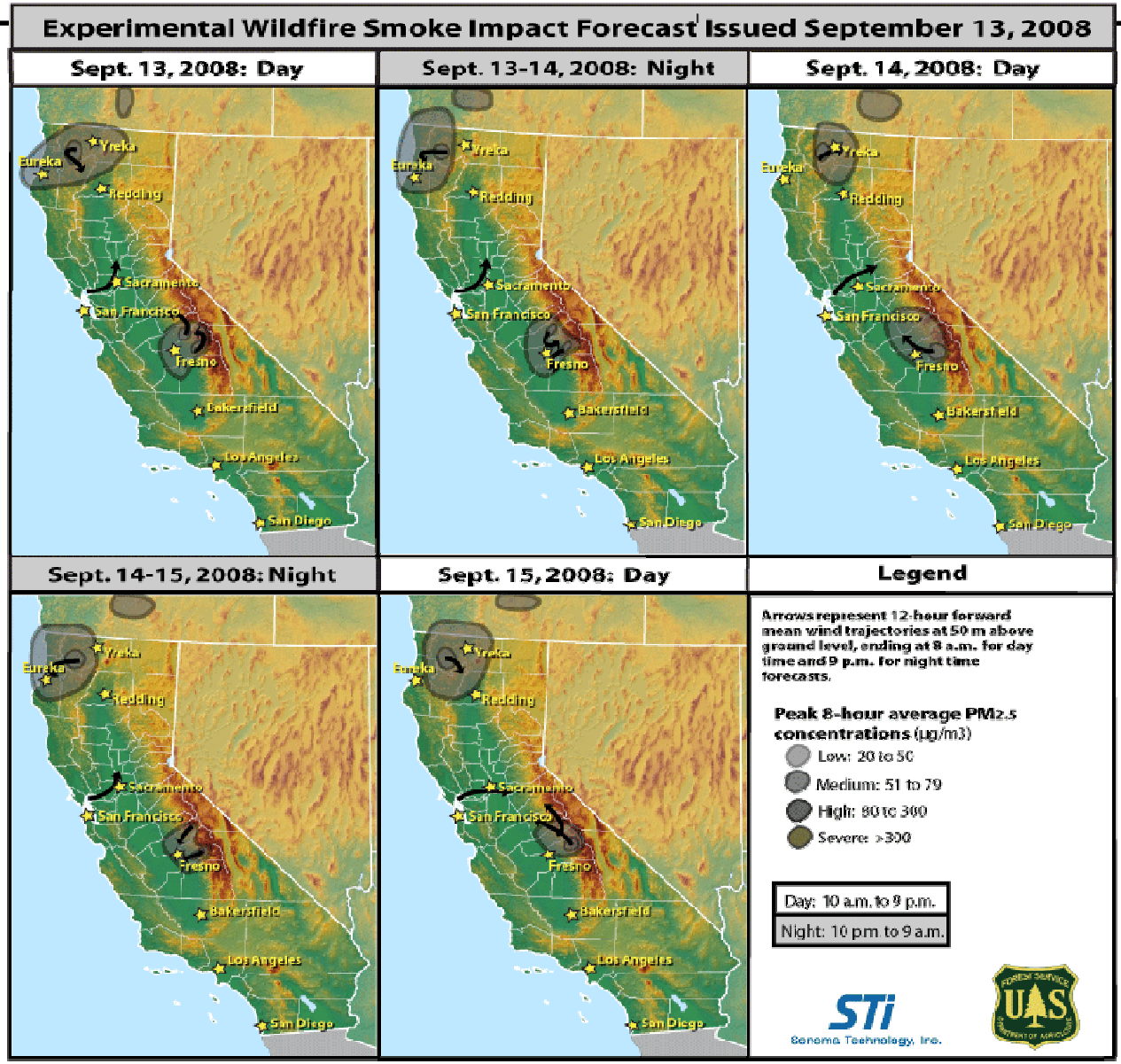
Daily Forecast Graphics

3 day, 2 night outlook

Prepared by air quality meteorologist

Forecast text summary

http://cefa.dri.edu/california



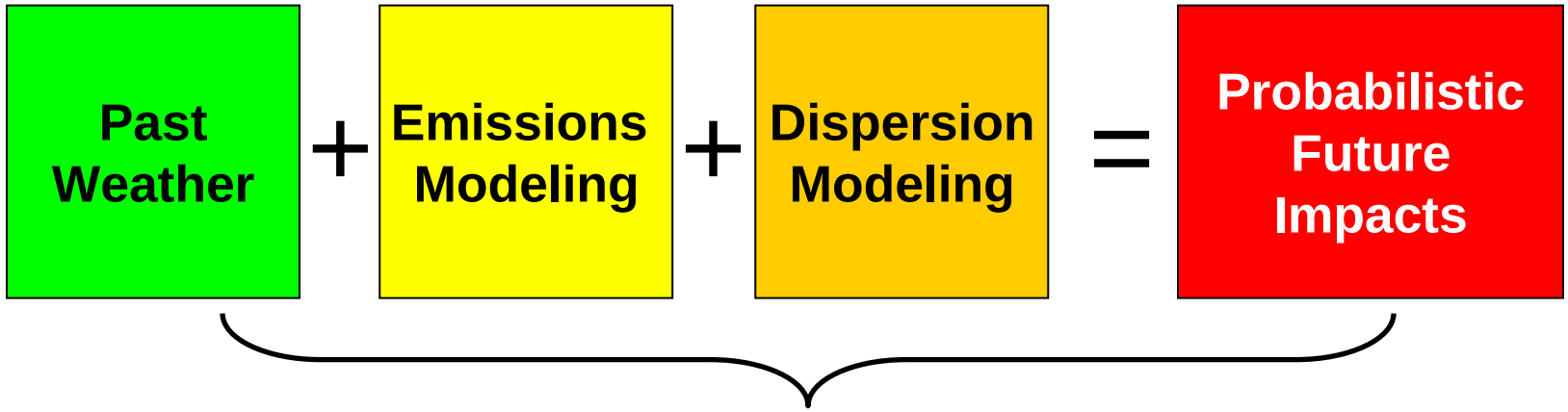
# AQUIPT: Longer-range planning

*air quality impacts planning tool*

Example: planning fire next Spring

Can't say what impacts **will be**

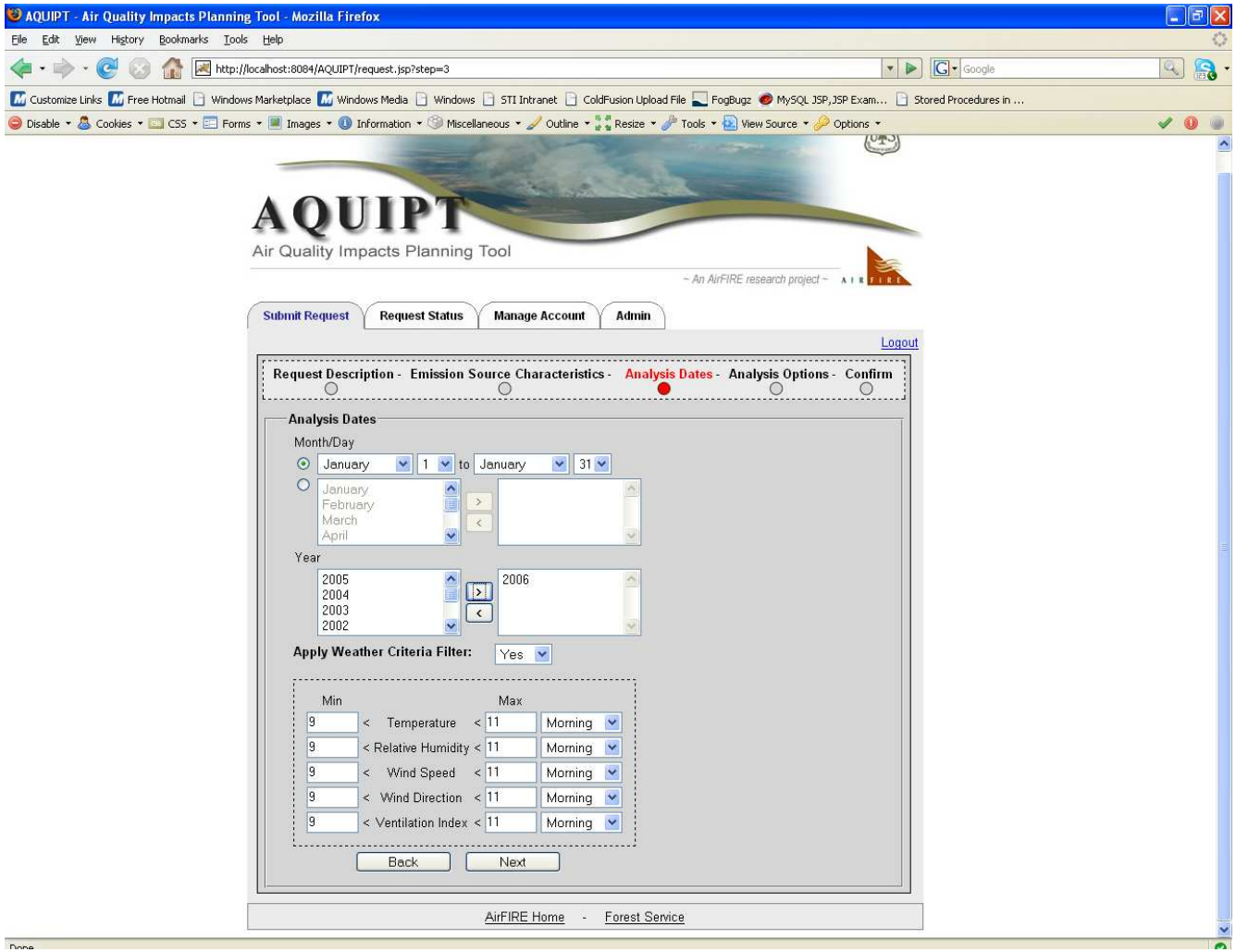
But can use **history as a guide**




Web Interface

# AQUIPT: Accessible through web

*air quality impacts planning tool*



# AQUIPT: Summary

Provides statistical answer to “what would have happened?”

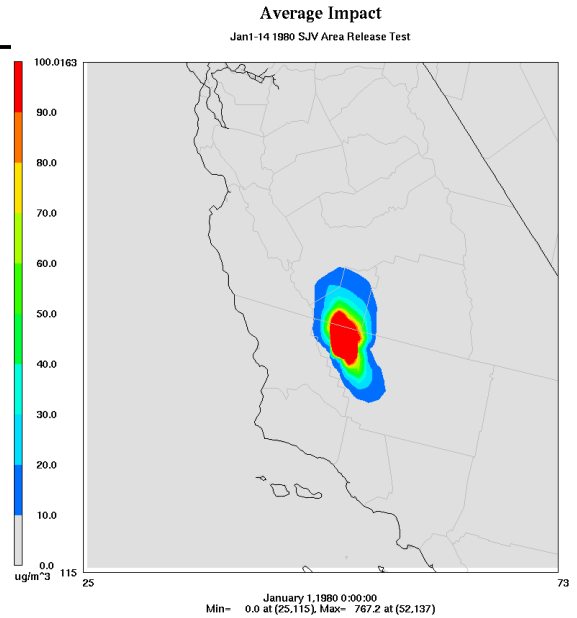
Provide basic source info, it does the rest

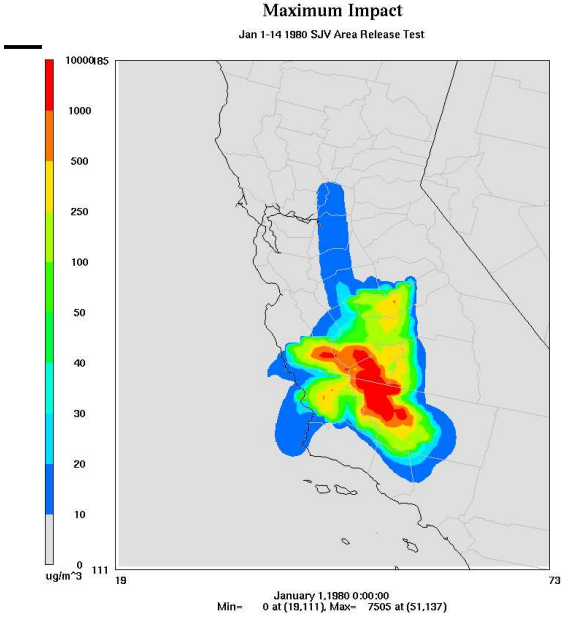
Not just fire

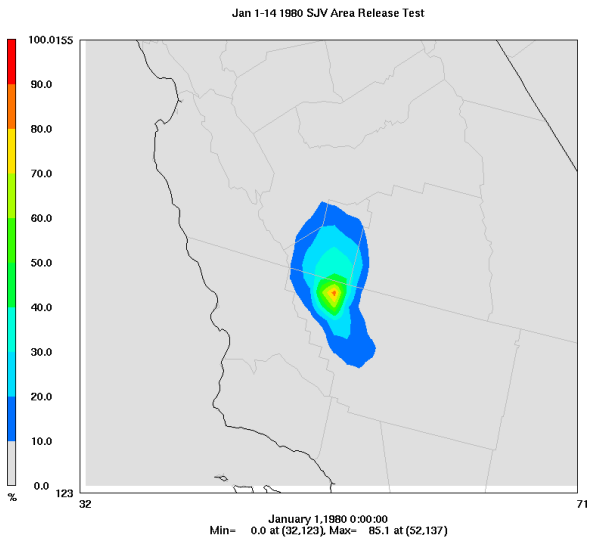
Uses 1979-2006 climatology

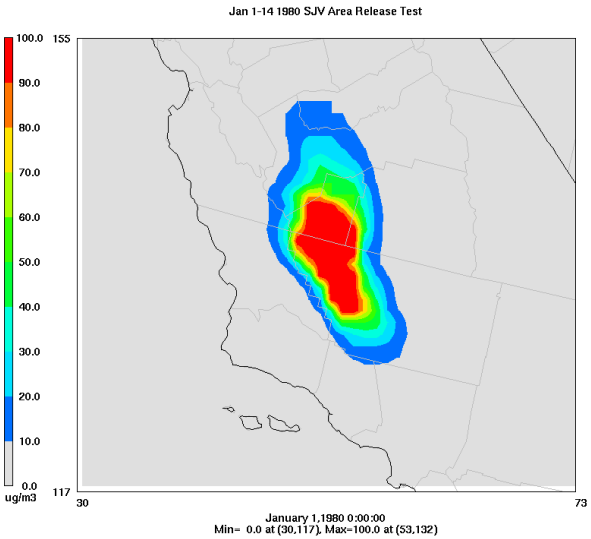
24-hr turnaround

Working on better graphics



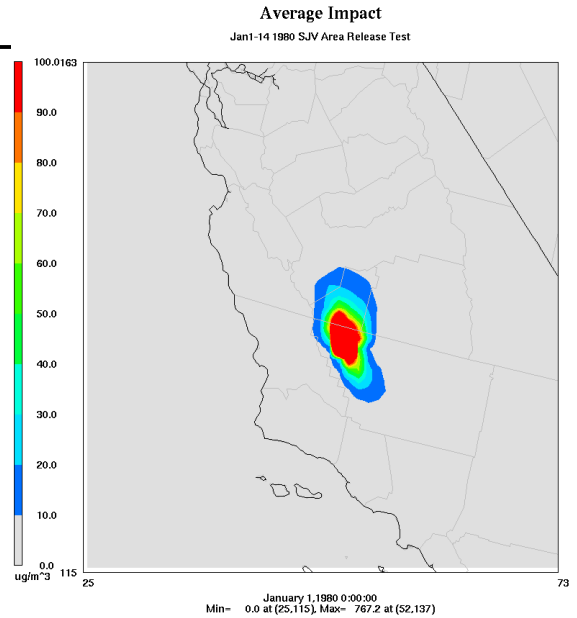



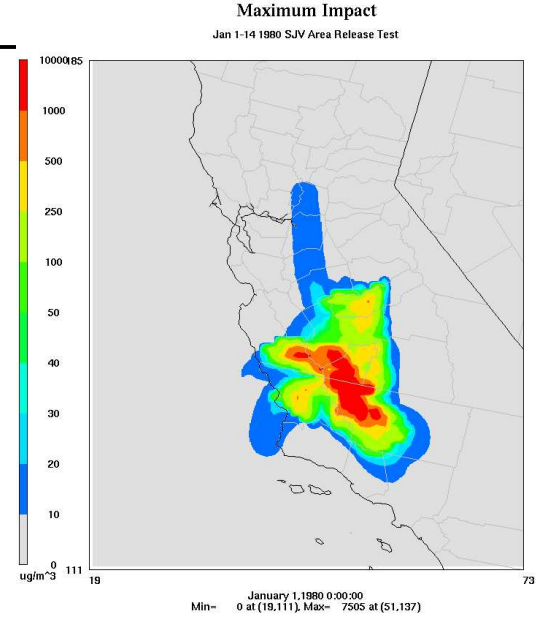



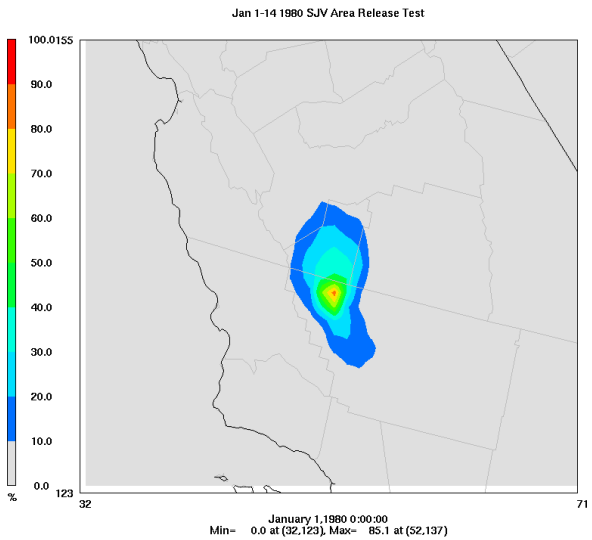
# WFDSS - Smoke Component

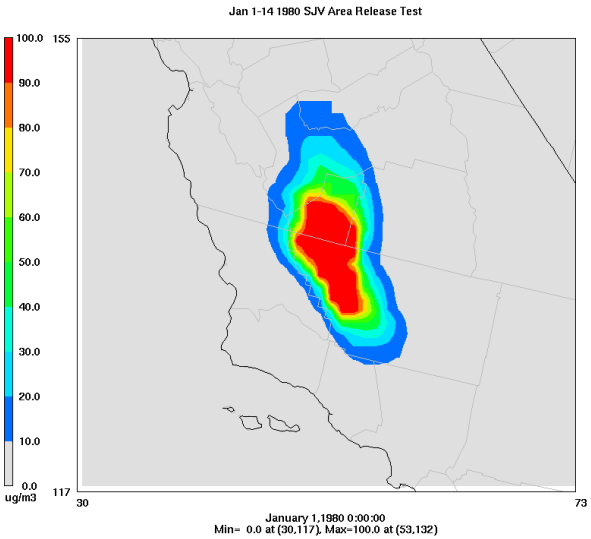
Probabilistic smoke impacts to go with FSPRO's probabilistic fire growth

Working w/
Mark Finney



# Thank you

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http://getBlueSky.org

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